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SUSTAINABLE ENVIRONMENTAL SANITATION AND WATER SERVICES

Design criteria: urban WSS Bangladesh

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IN BANGLADESH, THE demand for adequate and efficient urban Water Supply System (WSS) to feed the expanding urban areas is rapidly increasing. Population of Bangladesh, as of 2001, is estimated at 128 million with a density of 860 persons per sq. km. The population growth trend indicates that, despite steady decline in annual growth rate well below 2%, by the year 2020, the country's population is expected to reach 170 million. The urban population growth trend, on the other hand, indicates that, even under the steady growth rate of 5-6% every year, the increasing population pressure is likely to increase today's urban population from less than 20% to around 50% by 2020.

The National Water Supply Policy 1998 strives to provide every citizen with access to adequate water supply facilities. The Department of Public Health Engineering (DPHE) has been entrusted with the responsibility of establishing efficient WSS in all urban areas, except Dhaka and Chittagong cities. The WSS in these two cities are being developed by two Water Supply and Sewerage Authorities (WASA) called Dhaka WASA (DWASA) and Chittagong WASA (CWASA). These three agencies need to come up with a set of standard design criteria to improve their quality of planning, design and execution of their urban WSS. This called for planning, design and developing cities/towns having capacity to fulfill among other basic needs, safe water supply facility, which is vital to sharing human right and caring public health.

Under the WHO-DPHE Programme: Health and Environment, therefore, measures have been taken to develop a manual on Standard Design Criteria for Water Supply and Sanitation in Bangladesh. For this a Core Group was formed by DPHE to discuss the progress and decide on steps to be taken to progress further.

Bangladesh Engineering and Technological Services (BETS), a consulting firm, was engaged to provide necessary technical assistance to DPHE in this regard.

Based on the above mentioned arrangement, by now, a draft manual was prepared and an Expert Group Workshop convened to review the same, in order to examine its potential usefulness in the rapidly changing urban context of Bangladesh.

Organization of the standard design criteria

For planning, design and construction of the urban WSS, at present, different procedures, guidelines and standards are being practiced depending on the extent of knowledge and experience of the design engineers. In general, engineering

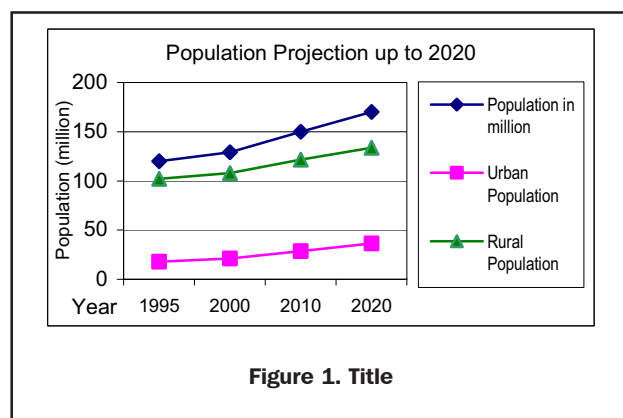


Figure 1. Title

consulting firms are contracted to do these design works. In the absence of standard design criteria, their output always carry the risk of making inconsistent designs leading to the problem of efficient performance and synchronization with previous works. It always involves high-cost public expenses compared to the country's annual revenue incomes earned from this sector. The present effort was, therefore, considered extremely important to meet the queries of the potential funding agencies, and make them feel confident about proper functioning of the urban WSS to be planned, designed and constructed, and also to make the total works technically possible, economically feasible and socially acceptable.

In preparing the above mentioned draft manual, the design criteria, which were used in the design of several water supply projects executed by DPHE, DWASA, CWASA and LGED, have been reviewed with special reference to their performance evaluation results.

Proper attention was paid to identify the limitations of the design engineers and weakness of the existing WSS designs and formulate a set of standard design criteria which can ensure high-quality, flexibility, provision of future expansion, and encourage energy savings, use of local materials, local construction practices and longer life of the water supply components.

The design philosophy

The philosophy behind the formulation of standard design criteria for the urban WSS was to:

- provide potable water to the urban areas by reliable process of treatment, whenever needed;
- provide simple, reliable and efficient collection system and adequate treatment to the domestic sewage prior to discharging in natural bodies;

- reduce inappropriate mechanization and instrumentation in the technologies;
- minimize the use of imported materials by using local materials whenever possible;
- design for maximum flexibility in operation and maintenance and for modification, extension; and
- ensure environment-friendly sludge disposal techniques.

The most challenging part of the design philosophy for urban water supply system of the developing countries like Bangladesh was identified as making the system cost-effective by limiting the use of imported materials, and at the same time ensuring their satisfactory performance and long life.

Population projection criteria

Present population of all the urban areas including 3 city corporations and 104 municipalities were used, and their population density and annual growth rate were calculated. Based on the population, the urban areas were then categorized as:

- high densely populated: Population > 200,000;
- upper-medium densely populated: 100,000 < Population < 200,000;
- medium densely populated: 50,000 < Population < 100,000; and
- low densely populated: Population < 50,000 and, that based on administrative status as:
 - Class-A: All the City Corporations;
 - Class-B: All the Class-A Municipalities;
 - Class-C: All the Class-B Municipalities;
 - Class-D: All the Class-C Municipalities

Then, based on the population density and annual growth rate, the population likely to reach at the end of the design period was calculated.

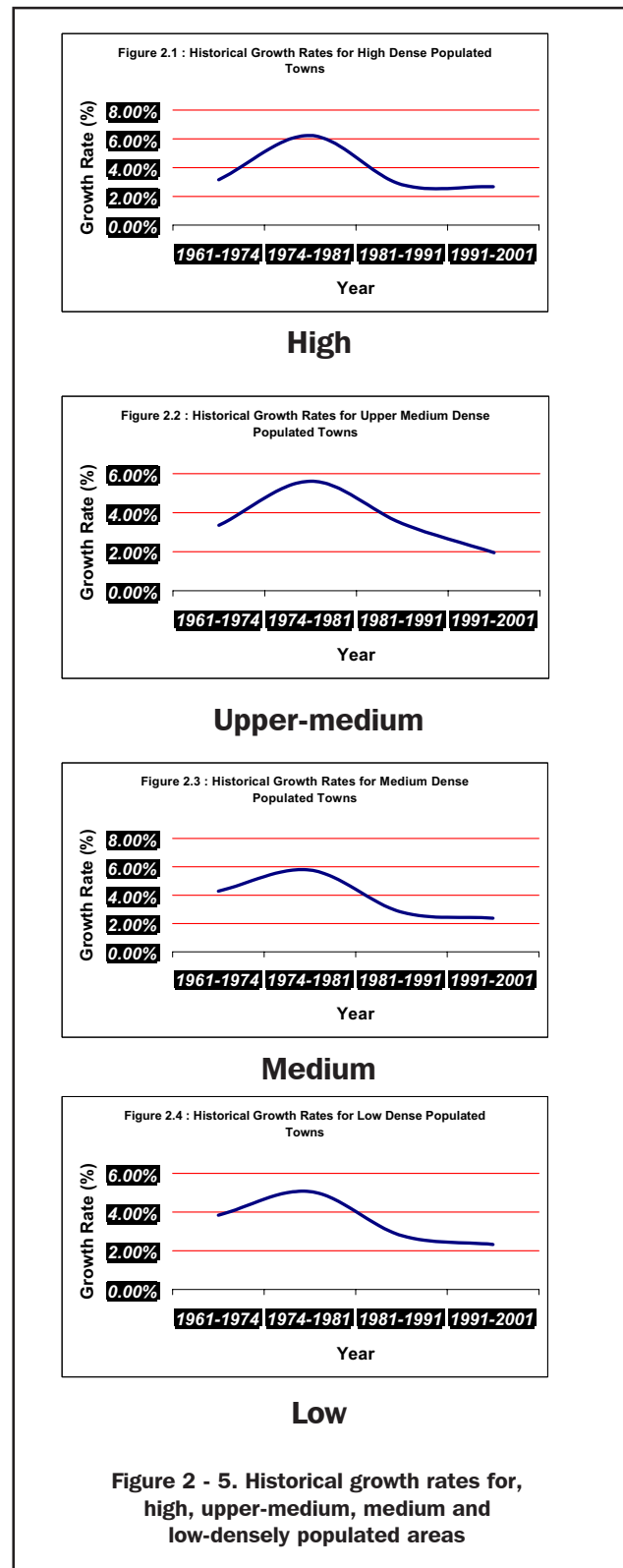
The following four Figures-2 to 5 demonstrate the historical growth rates for high, upper-medium, medium and low-densely populated areas as:

The projected population growth rates for the design period was determined by extending the above curves showing the historical growth rates from 1961 to 2001 with good judgement. It can be seen that the curves are s-shaped, showing an increasing growth rate of 5-6% up to mid 1980s, then gradually decreasing to 2% and even less by mid 1990s.

Estimation of the design period

Aside from the general practices, it was observed that the following points influence the design period of the Water Supply System as:

- expected population growth rate;
- present and future settlement pattern;
- economic life of the WSS system;
- interest rate on the donor's fund;
- existing inflation rate;
- cost-capacity function



- budget constraints; and
- future development potentials

Based on the above observations, the design period of Water Supply System for areas of high population growth rate (> 2%) was agreed at 15 years, and that for areas of low population growth rate was 20 years.

Table 1. Design period of water supply component

Sl. No.	Description of the Water Supply Components	Design Period (in Years)
1.	Production Tubewell	15
2.	Water Treatment Units	30
	- Civil Works	30
	- Electro-Mechanical Units	15
3.	Pipe connection to Treatment Units and other appurtenances	30
4.	Raw and Clear Water Conveying Mains	30
5.	Clear Water Reservoirs at the Head Works, Balancing Tanks and Service Reservoirs	30
6.	Distribution System	30
7.	Pumping Unit:	
	- Pump House; Civil Works	30
	- Electric Motor and Pumps	10

On the other hand, the design period of the **Water Supply Components** was estimated and agreed upon as mentioned in Table-1 below:

Estimation of the water demand

The demand for consumption of water for domestic purpose largely depends on existing socio-economic conditions of the consumers. In addition to the domestic purpose, water is supplied for industrial, commercial, institutional, livestock, fire fighting and recreational purpose also.

Keeping in view the multifarious demand for water plus potential losses due to human wastage and leakage in the distribution system, the consumers using water for domestic purpose were grouped as:

- High Income: Residing in independent houses;
- Middle Income: Residing in brick-built flats;
- Low Income: Residing in unplanned houses;
- Poor: Residing in slums, squatters etc.

Irrespective of the 61 district towns - large, medium and small, it was seen that high-income groups consume much more water for domestic purpose. The middle-income groups were found to be cautious in using piped water to limit their expense on the use of water. While, the low-income group and the poor were being deprived from getting sufficient water for personal hygiene practices even.

To reconfirm the above statement, in addition to the time-series data on domestic water supplies, a cross-sectional study was conducted with 400 households located in Satkhira Municipal area. It was revealed that the average consumption of piped water for domestic purpose by the high, middle, low and the poor-income groups were respectively 192, 129, 81 and 17 litres per capita per day (lpcd).

Informal discussion with these groups, further revealed that except the high-income group, the remaining three groups were also using hand tubewells and nearby pond water to compensate for the high cost of piped water, which was charged @ Tk 5.00 per cu meter by the Satkhira Municipality.

After analyzing the total per capita consumption of water of the 61 districts towns of Bangladesh, about 50 large towns of Asia and the Pacific Region and 400 households of the Satkhira Municipality the daily consumption of water of different income groups residing in different categories of urban settlements were estimated as follows:

It can be seen that the above estimated values stand valid for urban areas having partially metered piped water

Table 2. Domestic water consumption in 1pcd for partially metered connections

Income Groups	Class-A (Towns)	Class-B (Towns)	Class-C (Towns)	Class-D (Towns)
High	220	200	190	180
Middle	160	150	145	140
Low	110	105	100	100
Poor	30	30	30	30

facility, which is a common scenario in every town in Bangladesh. However, further estimation of that for the fully metered situation was also made. In that case, per capita consumption of water for all except the poor was estimated at a little lower value, which was less by 10 lpcd for the high-income, and 5 lpcd for the middle and low-income groups.

For further estimation of the demand for water to fulfill the industrial, commercial and institutional requirements, instead of population, the density of industries, business firms and institutions were used. A distribution of the estimated values according to the categories of towns are as follows:

Table 3. Industrial water consumption in 1pcd

Density of Ind.	Class-A (Towns)	Class-B (Towns)	Class-C (Towns)	Class-D (Towns)
High	25	20	18	18
Medium	18	15	14	14
Low	10	10	10	10

To mention here that, in case of particular industries where the demand for consumption of water becomes very high, a separate estimation procedure should be used.

The demand for water for livestock was considered to be zero for Class-A towns followed by 5, 8 and 10 respectively for the B, C and D categories. Regarding the demand for water for technical losses, it was considered safe to be on the higher side. Based on that, the estimated values were 20, 15, 12 and 10 lpcd respectively for the Class-A, B, C and D categories of towns.

Table 4. Commercial water consumption in 1pcd

Density of Ent.	Class-A (Towns)	Class-A (Towns)	Class-A (Towns)	Class-A (Towns)
High	20	15	13	13
Medium	12	10	10	10
Low	8	6	6	6

Table 5. Industrial water consumption in 1pcd

Density of Inst.	Class-A (Towns)	Class-B (Towns)	Class-C (Towns)	Class-D (Towns)
High	15	10	8	8
Medium	8	6	6	6
Low	5	5	5	5

Comparison of the water demand data

Finally, the estimated data on the per capita consumption of water for the 61 district towns of Bangladesh were compared with the data of 51 cities and town of Asia and the Pacific Region. It was seen that, in case of the 61 district towns, the estimated consumption of water was less than 100 lpcd in 55% towns, between 100 to 150 lpcd in 36% towns and over 150 lpcd in 9% towns. While, the data of 51 cities of the Asia and Pacific Region showed that the consumption of water was less than 100 lpcd in only 18% cities, between 100 to 150 lpcd in 35% cities and over 150 lpcd in 47% cities.

Nevertheless, variation in the demand for water due to seasonal fluctuation also received due attention and the multiplying factors were calculated at 1.2, 1.15, 1.15 and 1.10 respectively for Class-A, B, C and D categories of towns. For calculation of the **Daily Peak Demand**, the Hubbitt Equation was used. It was observed that the Peaking Factor was low, because majority of the consumers were maintaining underground water reservoir to avoid the risk of domestic water shortage.

Conclusion

Although the draft manual dealt with both water supply (WS) and sanitation, the present paper dealt with the rationale of WS only. This has been done to have detailed discussion within limited space.

The reviewers of draft manual had comments, primarily on the design period of the Treatment Plant, Clear Water Reservoir, Overhead Tank, Pump House and life of the Electric Motor and Pump, which have been incorporated in the paper.

In the Expert Group Workshop, the draft manual was accepted as a guidebook until further checking and validation of the empirical values through extensive laboratory test results.

Reference

Chowdhury, Jahangir (2001) "Standard Design Criteria and Manual for Urban Water Supply and Sanitation in Bangladesh.", WHO-DPHE, Dhaka.

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